(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 May 2003 (01.05.2003)

PCT

(10) International Publication Number
WO 03/035977 A1

(51) International Patent Classification[7]: D21F 7/08

(21) International Application Number: PCT/FI02/00817

(22) International Filing Date: 22 October 2002 (22.10.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20012050 23 October 2001 (23.10.2001) FI

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(81) Designated States *(national)*: AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK,

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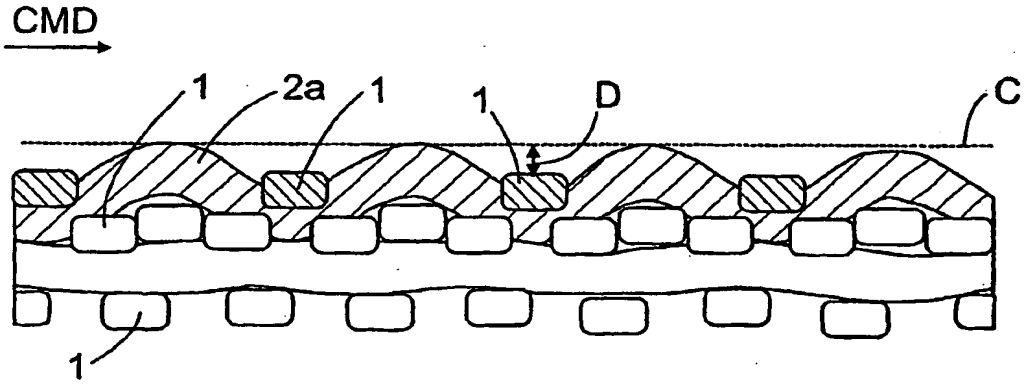
(54) Title: DRYING WIRE



(57) Abstract: The invention relates to a drying wire comprising machine-direction (MD) yarns, i.e. warp yarns (1), and cross-machine direction yarns (CMD), i.e. weft yarns (2a, 2b, 2c), the wire being a woven structure with 2.5 or more layers. The wire comprises surface wefts (2a) on at least one side of its surface, which surface wefts are made of a material that is more wear-resistant than the warp yarns (1). The surface wefts (2a) run on the surface of the wire at least over five warp yarns (1), having a long weft float. The weft yarns (2a, 2b, 2c) of the wire are to a great extent shrinkable in the longitudinal direction in heat, whereby, as a result of heat treatment of the wire cloth after the weaving, the surface wefts (2a) have bent to a curve outwards from the wire surface, extending thus essentially farther outwards than the warp yarns (1).

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TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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DRYING WIRE

BACKGROUND OF THE INVENTION

[0001] The invention relates to a drying wire comprising machine-direction yarns, i.e. warp yarns, and cross-machine direction yarns, i.e. weft yarns, the wire being a woven structure with 2.5 or more layers and comprising surface wefts on at least one side of its surface, which surface wefts are made of a material that is more wear-resistant than the warp yarns.

[0002] In the drying section of a paper machine, drying wires are used with which the paper web to be dried is directed through the drying section. The drying wire is formed of yarns resistant to high temperatures and moisture by using weaves suitable for the purpose. There are certain basic requirements for the structure of the drying wire. The drying wire must have certain permeability in order for the drying of the web to be efficient. On the other hand, the aerodynamic properties of the drying wire must be such that the runnability of the wire is good at high speeds. Further, the structure of the drying wire should not cause considerable wire marking in the web. On the other hand, at the end part of the drying section the web is already rather dry, so that there will not necessarily be any marking that far. Instead, with certain types of pulp and under disadvantageous conditions, the wearing of the wire may cause a problem.

[0003] It is known that there is a speed difference between the web to be dried and the wire, and correspondingly, between the wire and the rolls supporting the wire. For example, the high-draw differences cause differences in speed, due to which the wire may, depending on the situation, be abraded either on the paper side or on the background side. From the point of view of wire durability, the crucial thing is the wearing of the warp yarns, because the warp yarns are subjected to most of the forces that are directed at the wire during use. There have been attempts to improve wear resistance by using warp yarns having a thicker cross-section, but in such a case the basis weight of the wire increases, as do the manufacturing costs. Further, there have been attempts to affect the wear resistance by selecting such materials for the warp yarns that are more wear-resistant.

BRIEF DESCRIPTION OF THE INVENTION

[0004] An object of the present invention is to provide an improved drying wire of a new type having good wear-resistance and using properties.

[0005] The drying wire according to the invention is characterized in that the wear-resistant surface wefts run on the surface of the wire at least over five warp yarns, whereby they have a long weft float; that the weft yarns of the wire are to a great extent shrinkable in their longitudinal direction in heat; that the wire cloth has been heat-treated after the weaving; and that the surface wefts having a long weft float on the surface of the wire have bent to a curve outwards from the surface of the wire, extending thus essentially farther outwards than the warp yarns.

[0006] The essential idea of the invention is that the surface wefts are arranged at least on one surface of the wire to travel over at least five warp yarns and preferably under one warp yarn, whereby the surface wefts have long weft floats. The material of the surface wefts is more wear-resistant than that of the warp yarns. Further, the weft yarns are to a great extent shrinkable, whereby the wire cloth has been heat-treated after the weaving in such a way that the wire has shrunk intensely, seen from the cross-machine direction of the paper machine. Due to the cross-machine-direction shrinking of the wire, the surface wefts having a long weft float have bent to a curve away from the wire in such a way that the surface wefts extend on the surface of the wire clearly farther outwards than the warp yarns. Hereby, the surface wefts made of wear-resistant material protect the inner warp yarns against wear. Since the surface wefts thus attend to the wear resistance of the wire, the rest of the wire structure and the materials of the warp yarns and other weft yarns can be selected freely in such a way that the drying efficiency, the quality of the web to be dried and the runnability of the wire become as good as possible.

[0007] The essential idea of a preferred embodiment of the invention is that the surface wefts extending farthest from the surface of the wire are made of a material that has greater friction than the material of the warp yarns. Thus, the slipping due to the high-draw differences between the wire and the web can be reduced. Further, as the abrasion between the wire and the web/rolls is reduced, also the wearing of the wire is reduced.

[0008] The essential idea of a second preferred embodiment of the invention is that the cross-section of the surface wefts is flat, for instance substantially rectangular or oval. Flat yarns are more wear-resistant compared with round yarns, because they have a larger contact surface.

[0009] The essential idea of a third preferred embodiment is that the wire cloth is a 2.5-layer structure comprising surface wefts, bottom wefts and

intermediate wefts. Such a wire is steady and keeps its dimensions and form, owing to which it behaves in a stable manner in a paper machine.

BRIEF DESCRIPTION OF THE FIGURES

[0010] The invention will now be described in more detail with reference to the attached drawings, of which

[0011] Figure 1 shows schematically a cross-section and a machine-direction (MD) view of a wire structure according to the invention after weaving;

[0012] Figure 2 shows schematically a cross-section and a machine-direction (MD) view of the wire structure according to Figure 1 after heat treatment;

[0013] Figure 3 shows schematically a cross-section and a cross-machine-direction (CMD) view of a wire structure similar to the one in Figure 1 prior to heat treatment; and

[0014] Figure 4 shows the situation after heat treatment; and

[0015] Figure 5 shows schematically the weave structure of a wire according to the invention.

[0016] For the sake of clarity, the figures show the invention in a simplified form. Similar parts in different figures are denoted with the same reference numerals.

DETAILED DESCRIPTION OF THE INVENTION

[0017] The wire cloth shown in Figure 1 is formed of machine-direction (MD) warp yarns 1 and cross-machine-direction (CMD) weft yarns 2a to 2c. The structure has 2.5 layers. The surface weft yarn 2a travels in this case on the paper side A of the wire and the bottom weft 2b travels on the roll side B of the wire. Further, the weave comprises intermediate wefts 2c shown in Figures 3 and 4. The weft shown in Figure 1 is of a six-shaft type, in other words the surface weft 2a always runs over five warp yarns 1 on the paper side A of the wire and after that under one warp yarn 1, and moves on according to the same pattern over the next five warp yarns and so on. The surface weft 2a thus forms long weft floats on the paper side A of the wire, in which floats the surface weft 2a runs a relatively long distance E on the surface of the wire without being bound to the warp yarns 1. The other surface wefts of the cloth run according to the same weave structure. The run of the other wefts

2b, 2c and the basic structure of the cloth are selected in such a way that the firmness and stability required of a drying wire are achieved.

[0018] Depending on the weave type, weft floats may also be longer, in other words the surface weft 2a may run over more than five warp yarns.

[0019] Both warp yarns and weft yarns are monofilaments and they are made of a plastic material. Flat yarns are preferably used at least as surface wefts 2a. The advantage of flat yarns is, compared with round yarns, that they have a larger contact surface against the wearing surface. The cross-section of the surface wefts 2a may be a rectangle with rounded edges. Alternatively, flat wefts may be oval.

[0020] The warps 1 are preferably made of polyester (PES). It has been observed that the stability of the drying wire woven in a polyester warp is better than when polyamide warps are used. This is because polyester warps keep their dimensions and form better under different drying conditions than polyamide warps.

[0021] The surface wefts 2a are preferably made of polyamide (PA). Since the surface wefts 2a are subjected to less powerful forces compared with the warp yarns 1, the material of the surface wefts can be selected rather freely on the basis of resistance to wear, irrespective of the tensile strength. Further, the material of the surface wefts 2a affects the wire stability only a little. In addition to polyamide types PA6, PA66, compounded polyamides, polyamide copolymers and also polyuteran and polyether ketones, such as PEK, PAEK and PEEK, may be used as the material of the surface wefts 2a.

[0022] The other weft yarns 2b, 2c of the wire are preferably made of polyester. In such a case, said polyester wefts and polyester warps form a stable bottom cloth for the wire.

[0023] Further, the weft yarns are to a great extent shrinkable yarns, which means that the longitudinal shrinkage of an individual yarn is at least 10 %. Furthermore, the cross-machine-direction shrinkage on the wire is at least 10 %.

[0024] Figure 2 shows the cloth according to Figure 1 after heat treatment. As can be seen, the shrinkage of the weft yarns 2a to 2c in their longitudinal direction has caused cross-machine-direction (CMD) shrinkage of the cloth, whereby the warp yarns 1 have moved closer to each other. What is essential as regards the invention is that due to the shrinkage the surface

wefts 2a have bent to a curve because of their long float, whereby they extend farther outwards from the surface of the wire than the warp yarns 1. The position of the outmost point of the surface wefts 2a is indicated by broken line C. Further, Figure 2 illustrates, by means of line D, the distance between the upper surface of the surface weft 2a and the upper surface of the upper warp 1 in the vertical direction. Since the material of the surface wefts 2a is more wear-resistant than the material of the warp yarns, the surface wefts 2a form a protective layer on the surface of the wire. Before the warp yarns 1 become subject to possible abrasion, as much material must wear out of the surface wefts 2a as is shown by the distance D. The distance D is preferably 0.2 mm or longer, depending on the dimensions of the yarns used, for instance. As regards the durability of the wire, the crucial warp yarns are well protected against wear below the surface wefts in the wire according to the invention.

[0025] Figure 4 shows a cross-machine-direction view of the heat-treated wire cloth according to Figure 2. When it is compared with the situation after the weaving, shown in Figure 3, it is observed that the surface wefts 2a extend clearly farther outwards from the surface of the wire than the warp yarn 1. Further, Figures 3 and 4 show intermediate wefts 2c that have a considerable effect on the stability of the wire.

[0026] Figure 5 shows a wire cloth structure according to the invention.

[0027] The drawings and the related specification are merely intended to illustrate the idea of the invention. The details of the invention can vary within the scope of the claims.

CLAIMS

1. A drying wire comprising machine-direction (MD) yarns, i.e. warp yarns (1), and cross-machine direction yarns (CMD), i.e. weft yarns (2a, 2b, 2c), the wire being a woven structure with 2.5 or more layers and comprising surface wefts (2a) on at least one side of its surface, which surface wefts are made of a material that is more wear-resistant than the warp yarns (1) and in which

the wear-resistant surface wefts (2a) run on the surface of the wire at least over five warp yarns (1), whereby they have a long weft float;

the weft yarns (2a, 2b, 2c) of the wire are to a great extent shrinkable in the longitudinal direction in heat;

the wire cloth has been heat-treated after the weaving; **characterized** in that

the surface wefts (2a) having a long weft float on the surface of the wire have bent to a curve outwards from the surface of the wire as a result of shrinking due to heat treatment, extending thus essentially farther outwards than the warp yarns (1).

2. A drying wire according to claim 1, **characterized** in that the wire cloth has 2.5 layers, comprising surface wefts (2a), bottom wefts (2b) and intermediate wefts (2c).

3. A drying wire according to claim 1 or 2, **characterized** in that at least the surface wefts (2a) have a flat cross-section.

4. A drying wire according any one of the preceding claims, **characterized** in that the material of the surface wefts (2a) has been selected from the group polyamide, polyamide copolymer, polyuteran and polyether ketone.

5. A drying wire according to any one of the preceding claims, **characterized** in that the surface wefts (2a) are made of polyamide (PA) and that the warps (1) are made of polyester (PES).

6. A drying wire according to any one of the preceding claims, **characterized** in that distance (D) between the warps (1) on the wire surface and the upper surface of the surface wefts (2a) is 0.2 mm or longer after heat treatment.

7. A drying wire according to any one of the preceding claims, **characterized** in that the surface wefts (2a) are made of a material having greater friction than the material of the warp yarns (1).

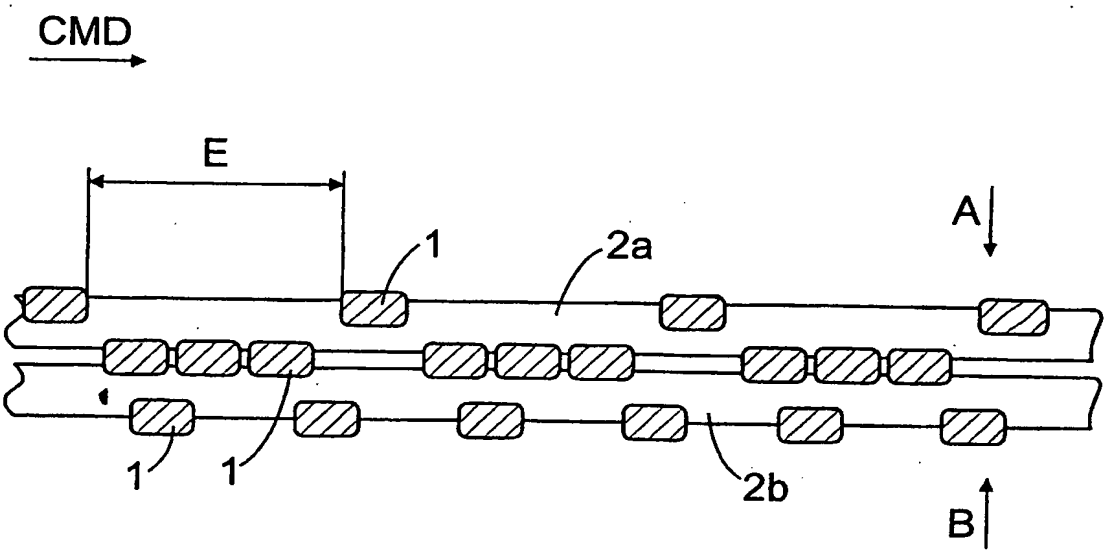

FIG. 1

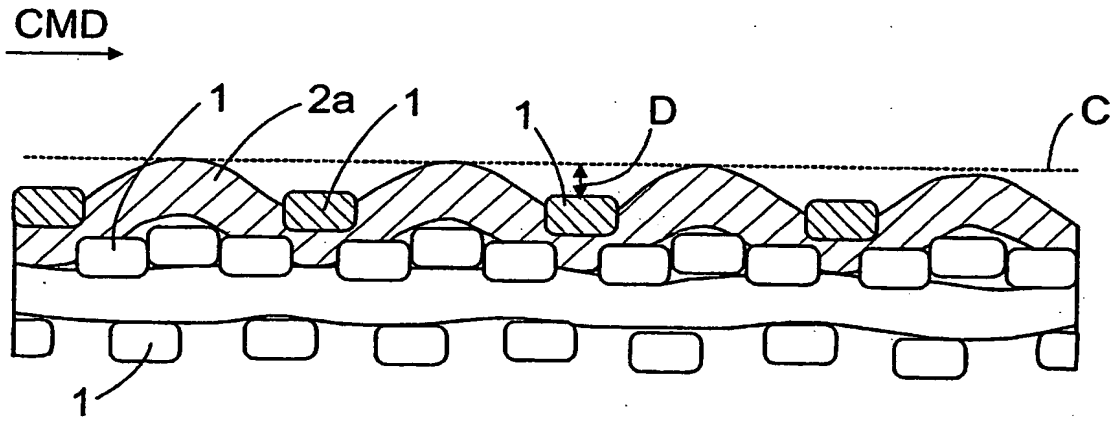

FIG. 2

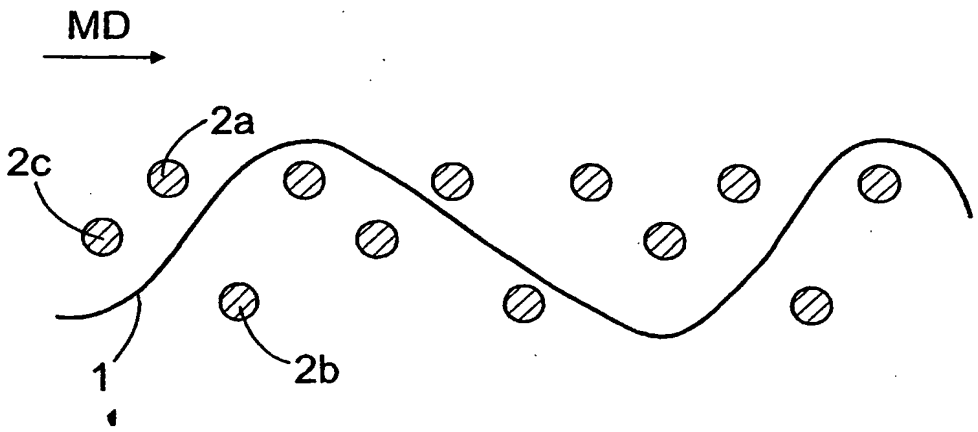

FIG. 3

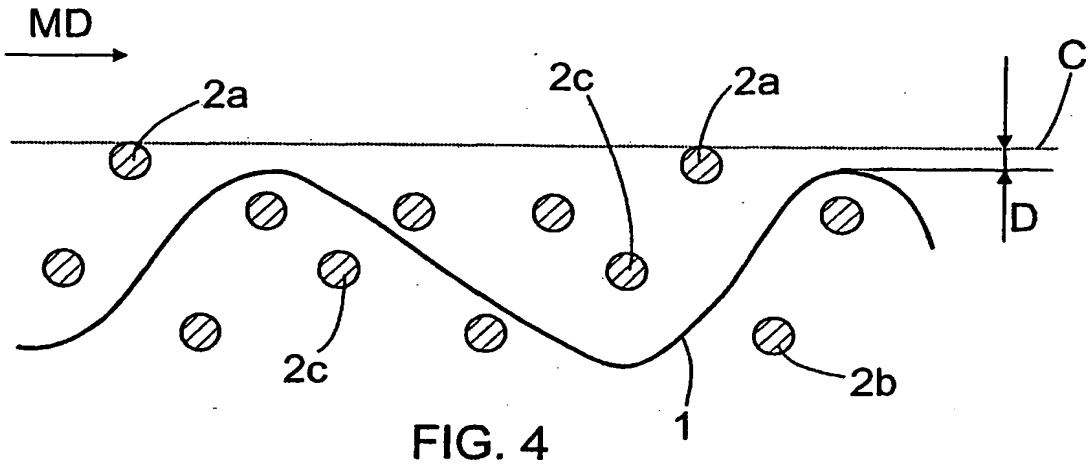

FIG. 4

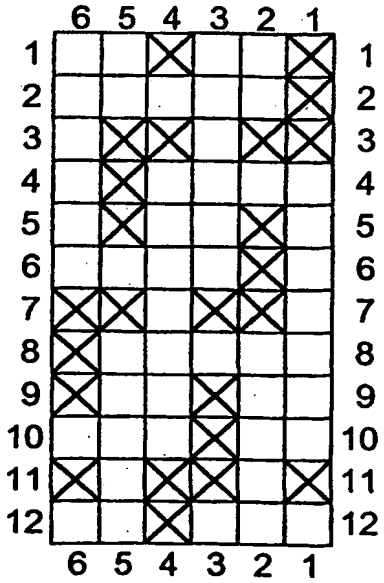

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00817

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21F 7/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5324392 A (TATE ET AL), 28 June 1994 (28.06.94) --	1
A	US 5116478 A (TATE ET AL), 26 May 1992 (26.05.92) -- --------	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 January 2003	21-01-2003
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INTERNATIONAL SEARCH REPORT

Information on patent family members

30/12/02

International application No.
PCT/FI 02/00817

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5324392 A	28/06/94	JP 2277847 A	14/11/90
		JP 2799728 B	21/09/98
US 5116478 A	26/05/92	NONE	

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